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SOVIET AUTHORS' SUGGESTIONS FOR AND DISCUSSION OF SPECIFICATIONS FOR DESIGNING SIBERIAN ELECTRIC POWER STATIONS

This report consists of two articles. (1) "Some Specifications for Designing Electric Power Stations in Siberian Regions," by L. Ye. Nebrat and V. N. Yasnikov, from Elektricheskiye Stantsii, No 11, 1949; and (2) "Discussion of the Article 'Some Specification for Designing Electric Power Stations in Siberian Regions,'" Part I by Engineer L. Ya. Lozanovskiy and Part II by Engineer K. N. Tush, from Elektricheskiye Stantsii, No 6, 1950.

SOME SPECIFICATIONS FOR DESIGNING ELECTRIC POWER STATIONS IN SIBERIAN REGIONS

As a rule, plans for electric power stations in Siberian regions have been drawn up on the same principles as plans for stations in other regions of the Soviet Union. Practice has shown, however, that important changes have had to be made both in building and in operating such stations, thus complicating the normal operation of equipment and incurring additional expenses. Many defects remain uncorrected, reducing reliability and economy of station operation and making poor working conditions for the personnel.

Long experience in operating large electric power stations under severe Siberian conditions makes it possible to set forth the following requirements for their design:

Fuel Economy

1. Railroads for electric power stations are usually designed on the supposition that coal and other materials will enter regularly. Under Siberian conditions when severe snowstorms and drifts make railroad transportation difficult, there are frequent delays in the entry of materials. Concentration of

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car deliveries and lack of balance between loaded and empty cars cause bottlenecks on the roads approaching the station. The lack of sidetracks makes movement on station lines more difficult. Re-equipment of the roads while in operation entails building curves of insufficient radius and loss of the space between roads usually used for storing materials. Lack of a second weighbridge causes the wagons to stand idle even more.

Hence, in designing electric power stations for Siberia, a thorough study must be made of freight regulation, sidetracks, a second complete weighbridge, and construction of water towers with chemically treated water.

2. Buildings for unloading coal should be heated. In one Siberian power station, serious difficulties were encountered in unloading coal from freight cars until the building was heated. The damp coal did not flow easily from the bunkers and needed constant stirring. When the stores of coal in the bunkers dropped, the walls of the bunkers froze, freezing the coal entering the bunkers when they were refilled. Stirring up the coal at the wrong time or breakdowns in the conveyers under the bunkers caused the coal to freeze into a monolithic mass in the bunker. The bunkers were out of commission for a long time, keeping many workers busy servicing the unloading unit.

After the installation of heating equipment, such difficulties were greatly diminished. The number of men unloading cars was reduced almost 40%. Their working conditions were greatly improved. Idle time for cars during unloading was also sharply reduced. Lack of heating in car dumpers with scrapers also caused considerable difficulty, reducing the fuel supply and increasing the manpower needed to remove the coal frozen in the bunkers and on slanting walls.

3. In building bunkers for coal, the bunkers should be equipped with trolley lorries. The experience of Siberian power stations has demonstrated that scrapers in bunkers do not operate as well as trolley lorries. Under winter conditions when comparatively damp coal enters, freezing is unavoidable and then the scrapers reduce productivity, since they press the coal into the bunkers. In addition, at the time of starting an impact, load is put on the cable and terminal units, causing more rapid wear and tear. The electric power required to deliver one ton of coal by means of scrapers is much greater than when trolley lorries are used.

4. In some large Siberian stations, the capacity of the coal bunkers in the boiler room itself is sufficient for 8 hours of operation. Experience has shown that this capacity is inadequate since it would provide operation of the boiler room for only 2.5-4 hours, allowing for a minimum emergency reserve in the bunkers.

Because of snowstorms and drifts, supply of coal to boiler room bunkers is frequently interrupted for long periods. It is not always possible to supply coal from open storage because the coal freezes. In addition, breakdowns of the coal conveyers make for very tight operating conditions.

The plan "Basic Principles for Designing Steam-Electric Power Stations, Substations, and Heat and Electric Power Networks," prepared in 1947 by the State Trust for Steam-Electric Power Planning, provides for further reduction in the capacity of boiler-room coal bunkers by fixing the minimum total capacity for coal and coal-dust bunkers at an 8-hour supply. Such a restriction absolutely cannot be applied to Siberian stations. Under such severe climatic conditions, a 16-hour supply must be provided.

5. Special buildings must be built for heating mazut and oil tanks. Lack of proper buildings for unloading mazut and oil transported long distances in winter weather causes excessive idle time for the tanks. Heating the mazut by steam in coils or applied directly to the tank is inadequate.

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Water Supplies

6. The reservoir should be equipped with two water outlets, one at the mouth of the basin and one for the intake chambers of the pump room. The basin mouth must be protected from ice movements by strong booms. The protracted frosts, lasting at times for 2-2.5 months with air temperatures of -45 to -50° C, cause deep freezing of the rivers and danger of the basin mouth freezing over.

An efficient method of controlling freezing conditions is to install heating equipment at the basin mouth. It is also necessary to deliver hot water to the intake chambers to control sludge ice.

The turbulent ice movement in Siberian rivers threatens the basin and intake grills with clogging by great masses of ice. Experience has shown that partitioning the mouth of the basin with strong, floating wooden booms is a satisfactory method of combating this situation.

7. Electric power stations built on Siberian rivers must have permanent installations for source-water coagulation. During the turbulent spring floods, characteristic of most Siberian rivers, water turbidity may amount to 2,000-3,000 mg/lit, creating an emergency in the stations because of the sharp drop in the output of the water-purification units.

Operations were restored to normal after equipment for preliminary coagulation of water was installed in several stations to treat the flood water before chemical purification.

The Main Building

8. The extremely short building season in Siberia greatly complicates the construction of reinforced-concrete buildings. The use of metal framework speeds up building, making it possible to use the winter season for finishing work. Hence, buildings should be designed for maximum use of metal framework.

9. For architectural reasons, when planning organizations design windows 60-70 sq m in size. The inevitable casement warping in windows of that size, the additional load on the glass and casements while covered with ice, and the additional load on the glass and casements while covered with ice, and the additional weight on the windows resulting from rarefaction in the boiler rooms -- all tend to break the glass and let masses of cold air into the building. The result is fog in the building, which makes working conditions worse for both personnel and equipment, especially for the electric motors. To prevent this situation, windows should not exceed 16-20 sq mm in size.

10. Outside doors and gates should have vestibules of sufficient length to prevent admission of cold air into the shops when personnel enter or loads are brought in. Building doors without vestibules, which has been common practice, complicates operating conditions. In shops subject to rarefaction, absence of vestibules often causes the door panels to break, complicating working conditions still more.

11. As shown by actual operation of Siberian stations, the usual type of skylights above the boilers make boiler-room conditions worse in winter because they admit a considerable amount of cold air, especially when under repair. Consequently, they should not be used to light the upper part of boilers during the day. If intended only for ventilation, the skylights could be simpler.

12. The exhaust-fan area, conveyer, crusher, and other spaces should be partitioned off from the boiler room. Failure to have such partitions is inexcusable. Windows, doors, expansion joints, skylights, etc., are closed and

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sealed to prevent penetration of cold air into shops under Siberian climatic conditions, and thus considerable rarefaction exists in the boiler room. Under these conditions, lack of partitions increases the amount of dust in the boiler room. This condition is so noticeable that the workers put up partitions to separate the boiler room from spaces containing equipment which collects dust.

13. Entrance of cold air through the boiler-room windows cannot be prevented because of vibration of window casements and consequent glass breakage; therefore, operating conditions require a larger number of heaters placed under the windows to form a heat screen. Consequently, plans for heating buildings subject to rarefaction must provide for heat screens near all windows.

14. Many of the operational difficulties mentioned above occur because normal ventilation is disrupted when all openings are sealed in winter and the pressure in boiler rooms drops 15-20 mm of a water column. The low pressure promotes dust accumulation on equipment and air contamination. Lack of well-organized ventilation makes the situation still worse, as it tends to raise the air temperature in working areas and passageways. Ventilation is, therefore, one of the most vital problems in designing Siberian electric power stations and must be fully provided for in drawing up plans. The pressure drop in boiler rooms when all openings are sealed in winter must not exceed 5-7 mm of a water column.

15. Placing certain types of equipment in the immediate vicinity of windows is not advisable. For example, drainage evaporators and turbopump exhausts should not be installed close to windows, since this arrangement would lead to heavy ice formation on the windows, causing the glass to fall out.

Placing generator bus bars under windows may lead to serious trouble because of heating and thawing of the glass and condensation on the busbar insulation when cold air enters through the windows.

Electric motors should not be placed in the immediate vicinity of windows, especially in boiler rooms, where there is a considerable degree of rarefaction. For example, in one large Siberian power station, exhaust-fan motors installed near the windows of the boiler room are still the weak spot in the station, and their insulation needs drying periodically.

16. The funnels and drains now manufactured have not been properly designed. They become clogged with ashes, preventing water drainage from the roof. Designers must find a satisfactory solution to this problem.

Electric Equipment and the Lubrication System

17. All 35-220 kv oil circuit breakers installed in open substations should be equipped with preheating devices. No explanation is needed beyond the statement that winter air temperatures are considerably below -45° C for long periods.

18. Long power-transmission lines from a state regional electric power station must be equipped with phase control and single-phase automatic repeated reclosing. The greater reliability of such lines is of special importance under Siberian conditions because looking for defects and obtaining the material and crews to eliminate them takes a great deal of time in winter and even in autumn and spring, because of bad roads.

19. Changing the oil in turbines, transformers, and large oil circuit breakers is very difficult in winter. The delivery of oil from the oil depot in casks demands extra manpower and makes the shops dirty. The central oil depot should have a pipeline for delivery and removal of oil from the turbine room and large electric units.

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DISCUSSION OF THE ARTICLE "SOME SPECIFICATIONS FOR DESIGNING ELECTRIC POWER STATIONS IN SIBERIAN REGIONS"

PART I

Along with the correct views put forward by Nebrat and Yasnikov, certain debatable and obscure statements should be noted.

With reference to the problem of heating car dumpers, the authors, after citing the experience of one Siberian power station, concluded that all types of car dumpers should be heated.

Such a generalization seems to us unfounded. Different approaches must be used in solving the heating problem for different types of car dumpers.

Car dumpers with slot-shaped bunkers and blade feeders actually do have the defects described by the authors. In such cases it is advisable and economical to heat the unloading sheds. It should, however, be pointed out that, beside heating the sheds with local heaters, it would be necessary to build at the gates air screens which would at the same time be centers for heating the air, to compensate rapidly (in an hour) for the heat used to warm the coal and the cars coming into the shed. If there is only local steam-heating equipment, the cooling of the shed when the gates are open and cold cars are brought in will be so great that the air temperature in the shed will immediately drop below zero and then rise very slowly.

It should be pointed out particularly that the time needed to heat the shed air to the required temperature after each introduction of a train will be so great, when only local equipment is used, that the original air temperature cannot be re-established before the entry of the next train. It will remain close to zero and will fall to zero the moment the cold cars enter.

To support this statement, we cite data on the heated shed in the very station to which the authors referred.

The heating equipment for the shed was designed to maintain the temperature inside the building at $+8^{\circ}$ C when the outside temperature was -45° C. The local heater system was also supposed to provide heat for the cars and fuel delivered to the shed.

During the 1947-1948 winter operations, the air temperature in the shed fluctuated from +16 and $+20^{\circ}$ C when the outside temperature was -18 to -20° C. After entrance of a string of cars, the shed temperature fell to +4 to $+12^{\circ}$ C, i.e., the temperature in the shed varied by 8 to 12° C.

It is obvious that for a calculated temperature of about $+10^{\circ}$ C in the shed and -45° C outdoors, the temperature variation upon entry of cars will be considerably greater, i.e., approximately $20\text{-}25^{\circ}$. Consequently, after entry of cars, the shed temperature will fall to -10 to -15° C.

Hence, any effective system for heating dumping sheds must consist of a combination of air screens and local heaters which will also serve as hot-air heaters.

Equipping the building and installing the heaters for a shed 100-120 m long would cost 300,000 rubles, while the operational costs would amount to about 75,000 rubles per year. Such a large expenditure for heating a shed could only be justified by a marked improvement of the unloading process in which slot-shaped hoppers with blade feeders are used.

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We cannot take issued with the authors' opinion that dumping sheds should be equipped with trolley lorries because of their satisfactory operation under severe climatic conditions, since heating of the shed has absolutely no effect on trolley lorry operation.

In the same way, heating of the unloading shed cannot affect the unloading of fuel from the cars, since cars having frozen fuel can only be defrosted by leaving them in the shed for a long time (about 10 hours) at a temperature of 90-100° C.

The only positive aspect of heating the shed is improvement of working conditions and thus an increase in labor productivity. But the economies effected do not justify the considerable expenditure for heating.

From these same considerations, we must agree with the authors' contention that scrapers should not be used under severe climatic conditions. For the existing scrapers, the problem of heating the dumping shed should be solved individually in each case on the basis of technicoeconomic calculations. It is expected that the results of such calculation will be against heating in the overwhelming majority of cases.

The authors' proposal concerning special buildings for the initial heating of mazut and oil tanks seems highly debatable to us. Heating of tanks in buildings would require the construction of expensive units similar to defrosters. Moreover, this method of defrosting tanks would demand considerably more time than defrosting by the conventional coils.

As for the problems the authors raised regarding rarefaction in shops, these are only a part of the general problem of organizing the air system in boiler rooms, a problem directly connected with heating and ventilation.

It should be stressed that the organization of the air system is of paramount importance in electric power stations under winter conditions. Particular attention is given to proper organization of the air system in the plans for heating and ventilation drawn up by the State Trust for Steam-Electric Power Planning.

Unfortunately, in most cases the planned systems and operating conditions are not feasible when put in practice for two reasons:

1. As a rule, only part of the ventilation units are installed, and, in some cases, none are installed.

2. There is no ventilation and heating service in the fullest sense of the word, i.e., a complete organization of the air system taking into consideration both technological air consumption and hygienic requirements in shops.

The chief factor hampering the operation of boiler and machine rooms is the air consumption by blowers and suckers along the gas line of the boiler unit, amounting to about 25 to 30% of the toal air consumption by blowers.

The consumption of air by blowers should be organized so that in winter only part of the air, corresponding on the heat balance sheet to heat liberation in the boiler room, should be taken from under the boiler room roof. The remainder of the air should be taken from the machine room (again in accordance with the machine room's heat balance sheet), from the ash pit, or wherever ventilation air exchanges can be used.

Delivery of outside air into the boiler room to compensate for air removed by suckers and blowers in the amounts indicated above can be organized by using ventilation units to force part of the air into the working space of the boiler

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room and ash pit. The remainder of the air is delivered thr ugh the adjustable casements in the upper part of the boiler room.

Strict observance of the above conditions alone will eliminate many negative factors noted by the authors in the following way:

1. The degree of rarefaction will be reduced considerably, thus reducing unorganized suction through the enclosures.

2. Penetration of cold air through closed skylights of the boiler room will become impossible.

3. Window glass and sashes will not be subjected to additional loads.

4. Noticeable air suction through the closed windows of the boiler room will be reduced and there will be no need to build the expensive heat screens proposed by the authors.

To decrease suction of cold air into the ash pit in winter, outside air preheated by hot air heaters is forced into the pit. This measure is extremely effective because the amount of energy required to pump the air through (with axial fans) is very small and the air is used simultaneously to ventilate and heat the ash pit and to feed the blowers. The amount of cold air taken from outside the ash pit and entering the blower will likewise be cut down.

The above considerations indicate that technological air consumption and the task of maintaining normal hygienic conditions are organically connected not only with the planning but especially with operating conditions where the plans are to be put in practice.

Unfavorable wintertime factors can and must be eliminated by intelligent operation of the heating and ventilating equipment, combined with equally intelligent organization of technological air consumption. Of course, the prerequisite for such results is the installation of all equipment and units called for by the ventilating and heating plan.

There has long been a demand upon ventilating and heating designers for sufficiently long vestibules at outside doors and gates. However, even where the plans have called for such vestibules they have not been built for one reason or another. The authors' proposal to build vestibules where needed should be embodied in standard resolutions of planning organizations.

We agree with the authors on the need for making skylights with reliably closing flaps, and we further must point out the need for mechanization and remote control of skylight casements. Otherwise, the operation of the skylight will not satisfy the required working conditions. Control of the window casements must also be mechanized.

For machine rooms in electric power stations operating under winter conditions for 6 months or more, we consider skylights unnecessary and even harmful. A common ventilation air exchange can be organized easily by using the slight degree of rarefaction in the boiler room to let the hot air of the machine room into the ventilation units of the boiler room. Consequently, making a fanlight above the boiler room to act as an exhaust fan would be superfluous (this statement is corroborated by calculations of the heat and air balance).

In conclusion, we feel that we should stress that solution of the problems involved in eliminating shortcomings in the operation of electric power stations under winter conditions depends chiefly on the workers. Substantiating this conclusion is the fact that organization of air economy in plants now operating lags somewhat behind the solution of these problems by designers.

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PART II

It is both timely and proper to consider special climatic conditions in designing electric power stations for Siberia. The following additions might be made to the proposals put forward by Engineers Nebrat and Yasnikov.

1. In designing electric power stations with a closed cycle of water supply and cooling water in sprinkler tanks, no other buildings should be erected closer than 100 m, since they will ice heavily in winter. Pillar supports under pipelines must be metal with an anticorrosive coating, since reinforced-concrete supports disintegrate rapidly in winter. The plans must include nozzles on the supports to wash away the ice coating which forms on the supports in winter.

2. The pit capacity of the dumping shed must be designed for a 48-hr supply of fuel, because arrivals of coal are irregular in winter and delivery from stocks is made difficult by drifts and frost. The dumping shed must be equipped only with trolley lorries. Experience has shown that 10-ton trolley lorries, with jaws having a capacity of 5 cu m, can deliver fuel at a rate of 120 tons per hour per lorry in a maximum run of 90 m. Scraper installations operate much less efficiently. Two scrapers can hardly provide 80 tons of fuel per hour.

3. Equipment for the production of pulverized coal dust should be installed only in heated buildings.

4. Boiler room skylights should be designed only for ventilation purposes; it not needed for that purpose, they should not be built.

5. Ventilation problems should not be postponed until the second plan but decided at the same time as planning problems connected with the production buildings. Special attention must be paid to ventilating the fuel supply and machine room, because it is more difficult to maintain sanitary working conditions in these spaces under winter than under summer conditions.

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